This paper summarizes what is done for the experimental testing of cermet fuel with various matrix materials. Low neutron absorption, high heat conductivity, good corrosion resistance in water, low chemical interaction with cladding (zirconium alloy) and UO_2 in normal and accident conditions, technological ability – are the requirements of the matrix material. Suitability of the proposed solutions to the cermet fuel design with respect to these requirements was proven through a series of experiments simulating fuel operating and accident conditions.

02/01970 Coated particle fuel to improve safety, design, economics in water-cooled and gas-cooled reactors

Porta, J. *et al. Progress in Nuclear Energy*, 2001, 38, (3–4), 407–410.

In the context of Inert Matrix Fuels (IMF), coated particles (CP)s may play an important role to reduce the problems connected to the plutonium (Pu) and minor actinides stockpiles. In addition, the coatings of the fuel kernels made of different low and high-density ceramic layers allow a safe containment of fission products in operational, accidental and disposal conditions. Pu-based CPs embedded in a ceramic matrix (e.g. graphite, like in HTR fuel elements) can be judged as a special cercer type. There is a wide variety of different coatings and kernel compositions that has not yet been explored beyond the HTR development. Thus it can be expected that the CP technology can be applied to other reactor systems, too. For getting full benefit of the fission product retention capability of the CPs, not only the particle design but also the core geometry as well as power densities etc. have to be adopted to each specific requirement.

02/01971 Complex behavior in quaternary zirconias for inert matrix fuel: What do these materials look like at the nanometer scale?

Conradson, S. D. *et al. Progress in Nuclear Energy*, 2001, 38, (3–4), 221–230.

Conventional crystallographic analysis of cubic zirconias (CSZ) over a wide range of stabilizers and the stoichiometries has shown O atom displacement along lattice vectors and cation disorder with irreproducible characteristics. However, because diffraction is only sensitive to the average long-range order and biased towards periodic and symmetric distortions, it is essential to supplement it with probes of short-range order that may reveal additional, element-specific details about local ordering. We have performed X-ray Absorption Fine Structure (XAFS) spectroscopy measurements on a series of Er-Y-(U-Ce)-Zr oxides to determine the local environment around each of the cations. Results from these experiments demonstrate that not only are there significant element- and composition-dependent distortions away from the crystallographic structure but also interactions between specific pairs of the metal ions indicative of cooperative behaviour. This suggests that some of the metal ions are not randomly, isomorphically substituted into the lattice but instead have tendencies to form nanometre-scale clusters and networks. In this respect, substantial differences are seen in the influence of Ce and U on the Y-centred distortions, consistent with different roles for these two elements in inert matrix fuel (IMF) matrices. This type of nanometre-scale heterogeneity is typically coupled to the phase stability and other properties of other materials and may therefore be important to these zirconias in their IMF application.

02/01972 Composite materials and systems as alternative inert matrix fuel to dispose civil or weapon grade plutonium in light water reactors

Vatulin, A. V. *et al. Progress in Nuclear Energy*, 2001, 38, (3–4), 321–326.

To complete the IMF cercer studies on the problem of Pu utilization in LWRs, a cermet fuel approach is presented. The advantages of cermet fuel are associated with high heat conductivity, ability to retain the fission products and a well-developed fabrication process. Attractive possibilities for the creation of new cermet fuels and cermet fuel elements are also presented. R&D activity aimed at the development of cermet fuel element with PuO_2-Zr composite was undertaken. As a result of this activity comparative analysis of thermodynamic calculations for UO_2-Zr and PuO_2-Zr composites was carried out, as well as an assessment of Pu loading and preliminary thermal calculations. As a consequence, it was concluded that the PuO_2-Zr cermet system could be considered as a possible variant of new cermet fuel and cermet fuel element for Pu burning in LWRs.

02/01973 Control of reactor pulses by external neutron injection

Pepyolyshev, Y. N. and Popov, A. K. *Annals of Nuclear Energy*, 2001, 28, (16), 1613–1624.

It is shown that it is possible to regulate the energy of each pulse of a powerful pulsed periodic reactor using an injector of relatively low power. The target in the reactor core generates the neutron pulses forced by the injector. The correlations for determination of the moment of injection are obtained. The equation connecting the mean reactor power, the intensity integral of the target and the scatter multiplicity of the pulse energy without injection is obtained. In addition to its function as a regulator, the injector plays the role of an auxiliary emergency unit. It is shown that using an injector provides a regime in which the reactor can generate power pulses in the form of periodic packets.

02/01974 Current status of researches on the plutonium rock-like oxide fuel and its burning in light water reactors

Yamashita, T. *et al. Progress in Nuclear Energy*, 2001, 38, (3–4), 327–330.

Intention of the ROX-LWR system research is to provide an option for utilization or disposition of surplus plutonium. Researches on inert matrix materials and irradiation performance shows that the most favourable candidate for the ROX fuel is a particle dispersed fuel where small particles consisted of yttria stabilized zirconia, PuO_2 and some additives are homogeneously dispersed in spinel matrix. Reactor safety analyses show that the ROX fuelled PWR core has nearly the same performability as the existing UO_2 fuelled PWR under both reactivity initiated accidents and loss of coolant accidents.

02/01975 Dissolution and analysis of erbium doped cermet fuels

Coulon, J. *et al. Progress in Nuclear Energy*, 2001, 38, (3–4), 431–434.

Cermets are suggested as new kind of nuclear fuel to reduce global costs. They need high enriched fuel and thus use of burnable poison. Special pellets were developed and irradiated to test such concepts. Some pellets consist of a cermet fuel. With an improved fuel thermal conductivity (by using metal matrix), lower temperatures than standard fuel are obtained. Some pellets were made of cermet and erbium in small quantity. Studies on erbium were launched to determine the influence of this neutron poison. Standard dissolutions (HNO_3, HF) on cermet (Mo-UO_2) and on erbium doped cermet show a large amount of insoluble matter. Tests have been carried out in order to establish a procedure for a complete dissolution of active pellets. Consequently, an optimal process was defined. Irradiated pellets from experimental reactor SILOE will be dissolved. Analytical chemistry studies were undertaken. Thermal Ionization Mass Spectrometry (TIMS) and Glow Discharge Mass Spectrometry (GDMS) have been applied. The U and Er isotopic composition has been determined on different samples.

02/01976 Dynamics aspects of plutonium burning in an inert matrix

Damen, P. M. G. and Kloosterman, J. L. *Progress in Nuclear Energy*, 2001, 38, (3–4), 371–374.

Burnup calculations have been performed on a mini fuel assembly containing 21 fuel rods and four water holes at the corners. The fuel rod positions were filled with 4% enriched UO_2 fuel and with either reactor grade or weapons grade plutonium mixed in an inert matrix. The ratio between the UO_2 and the IMF rods was varied to investigate the influence of the UO_2 fuel on the dynamics of the assembly. From a simple reactor model with one delayed neutron group and first-order fuel and temperature feedback mechanisms, the linear transfer function from reactivity to reactor power was calculated that was subsequently used in a root-locus analysis. From this, it is concluded that only 20% of the fuel rods need to be made of UO_2 to have a fuel that is linearly stable up to 1000 days of irradiation.

02/01977 Elements of comparison between different inert matrix fuels as regards plutonium utilisation and safety coefficients

Baldi, S. and Porta, J. *Progress in Nuclear Energy*, 2001, 38, (3–4), 375–378.

The current international trend is to focus towards the utilization of plutonium. The use of composite fuels in inert matrix (U-free) is a potentially efficient solution to this problem. This document deals with the cermet fuels, selected for their excellent behaviour under irradiation and their high thermal conductivity. The emphasis is placed on the study of kinetic coefficients. Comparisons are performed with other solutions that use other composite fuels, especially the Solid Solutions and ROXs. As core control requires as heterogeneous assembly, an assembly whose characteristics are compared to the APA reference is proposed.

02/01978 Experimental study and modelling of the thermoelastic behaviour of composite fuel in reactors – Emphasis on spinel based composites

Georgenthum, V. *et al. Progress in Nuclear Energy*, 2001, 38, (3–4), 317–320.

Among the different ways studied to transmute minor actinides (MA), the heterogeneous mode is preferred, where high contents of MAs are put in selected reactor locations. An inert matrix fuel (IMF) with MA compound particles is commonly considered. Its specificities are such that its behaviour under irradiation cannot be predicted directly by standard fuel codes. In the reactor, the IMF thermomechanical